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GB 2328197 A
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EP 0171136 A1

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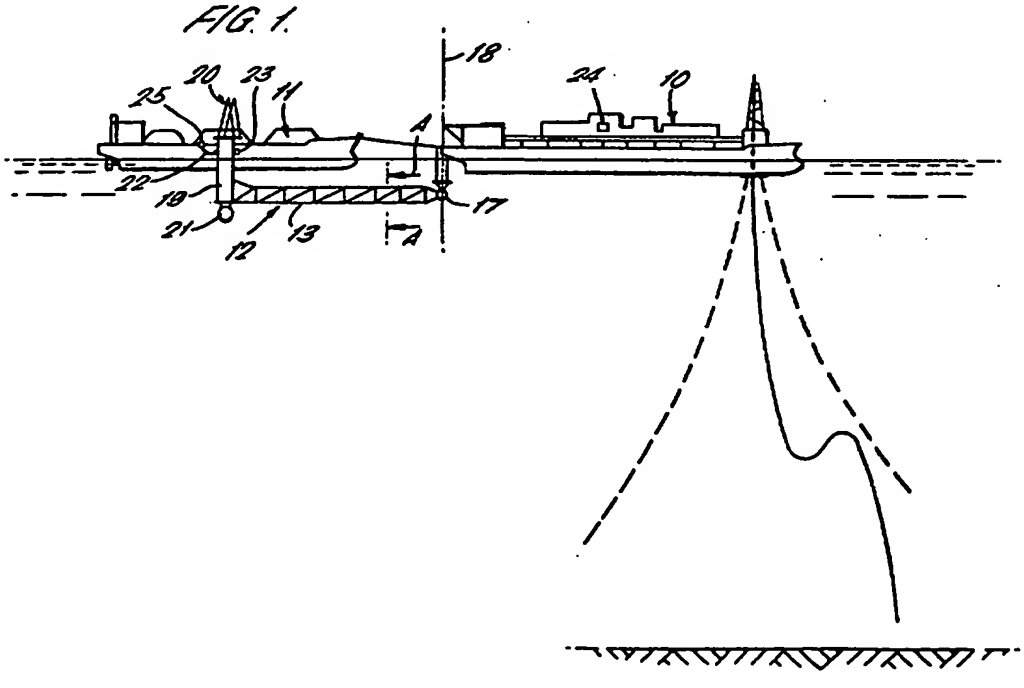
(54) Abstract Title
Offshore fluid transfer system

(57) Apparatus (12) for transferring fluid between a first structure and a floating vessel is described, comprising a submerged rigid transfer arm (13) defining a fluid conduit for receiving fluid from a first structure (10), means (17) to attach a first end of the arm (13) to the first structure (10) so as to allow the arm to pivot about at least two axes, and loading means (20) located at the second end of the arm (13) and attachable to a floating vessel (11) for transferring fluid from the fluid conduit to the floating vessel(11). The apparatus (12) is provided with thrusters (21) and positioning monitoring means (24). A control system (25) operates the thrusters (21) to move the arm (13) if the position monitoring means (24) shows the separation of the arm (13) and the second vessel (11) is outside a given range, to restore the separation to within the range. The system also monitors attachment of the vessels and shuts down the transfer if disconnected.

FIG. 1.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

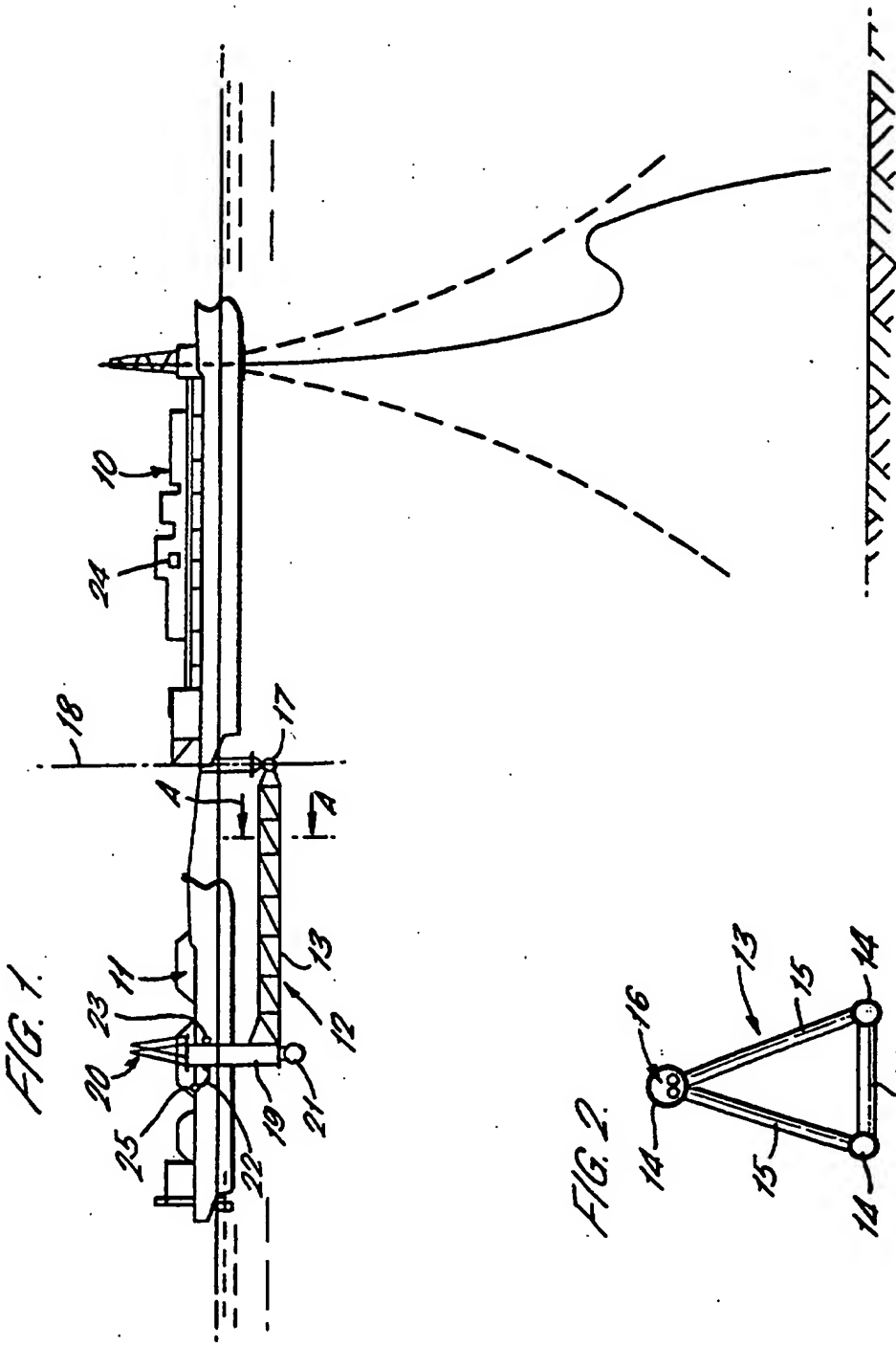


FIG. 1.

FIG. 2.

FIG. 3.

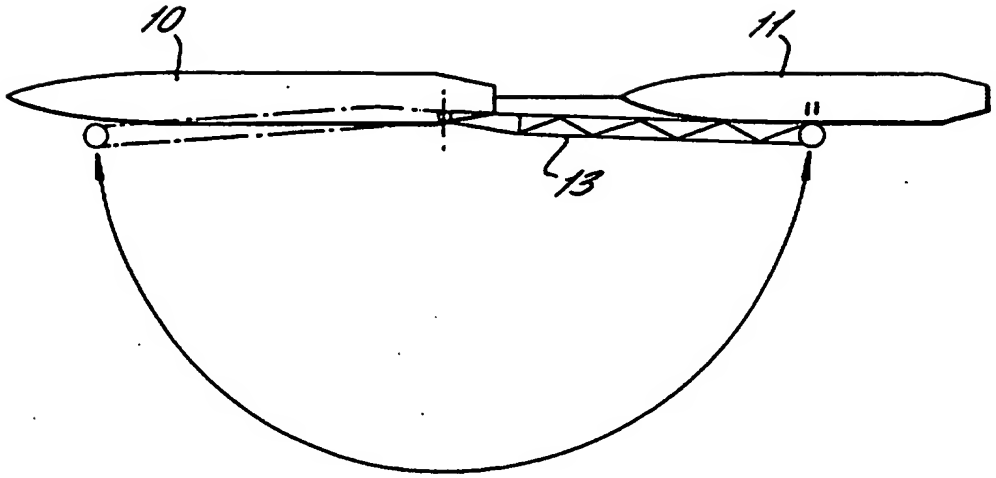
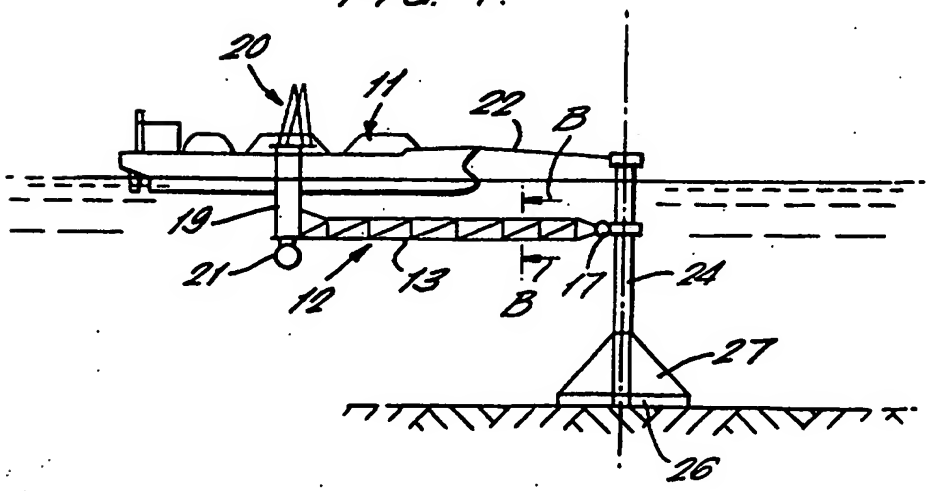


FIG. 4.



OFFSHORE FLUID TRANSFER SYSTEM

The present invention relates to apparatus for transferring fluid between two structures, for example two floating vessels, or a fixed offshore structure and a vessel.

Transferring fluid, particularly of a cryogenic product, between two floating vessels, or a fixed offshore structure and a vessel, is a difficult and hazardous operation when performed in open sea. Various systems for transferring fluid have been proposed. For example, UK patent 2328196 describes a system which employs a rigid arm, one end of which is fixed in an articulated fashion to a storage vessel. The other end is supported by means of a flotation tank. A receiving vessel can be moored to this end of the rigid arm to receive fluid transferred from the storage vessel. The fluid transfer system between the rigid arm and the receiving vessel may be handled by articulated rigid pipes, for example of the type described in US patent 3,556,148.

One disadvantage of such a system is that when the rigid arm is connected to the floating vessel, the action of wind and waves may cause sudden changes in the separation of the arm and vessel. This may impose unacceptable loads on the fluid transfer system or even cause the arm and vessel to collide. Therefore, there is a need to improve the relative motion behaviour between the rigid arm and the recipient vessel.

Accordingly, the present invention provides apparatus for transferring fluid between a first

structure and a floating vessel, comprising a rigid transfer arm defining a fluid conduit for receiving fluid from a first structure, means to attach a first end of the arm to the first structure so as to allow the arm to pivot about at least two axes, loading means located at the second end of the arm and attachable to a floating vessel for transferring fluid from the fluid conduit to the floating vessel, wherein the apparatus is provided with thrust means operable to rotate the rigid arm relative to the first structure about a substantially vertical axis in use, position monitoring means to monitor the separation of a point on the arm and the floating vessel and a control system operable to actuate the thrust means if the separation is outside a predetermined range, so as to move the arm relative to the floating vessel thereby to restore the separation to within the predetermined range.

In this way, the risk of large loads or collisions damaging the transfer system is reduced.

Preferably, the apparatus further comprises mooring means to moor the apparatus to the floating vessel, means to monitor whether the mooring means is attached to the floating vessel and means to automatically disconnect the loading device from the floating vessel if the mooring means becomes detached from the floating vessel.

If the loading device is automatically disconnected from the floating vessel, the control means is preferably also operable to actuate the thrust means to move the arm away from the floating vessel.

The first structure may be a floating vessel or a seabed mounted structure.

The rigid arm may be a space frame construction having a plurality of longitudinal members joined by a plurality of transverse bracing members. Conveniently, the fluid conduit is located inside at least one of the longitudinal members. Insulation may be provided around the fluid conduit.

Preferably, the fluid conduit is provided with flexible connections allowing it to bridge the pivot points in the apparatus.

The loading means may comprise a cryogenic loading device.

The invention also provides a method of transferring fluid from a first structure to a floating vessel using the apparatus as described above, comprising the steps of: actuating the thrust means to pivot the arm in a first direction about an axis defined by the attachment means relative to the first structure, moving the floating vessel into a position in the vicinity of the first structure, actuating the thrust means to pivot the arm in a second direction opposite to the first direction so as to bring the loading means adjacent the floating vessel, connecting the loading means to the vessel and transferring fluid from the fluid conduit to the floating vessel, disconnecting the loading means from the floating vessel, and actuating the thrust means to pivot the arm in the first direction away from the floating vessel; wherein, while the loading device is connected to the floating vessel, monitoring the

separation between a point on the arm and the vessel, and operating the thrust means if the separation is outside a predetermined range so as to move the arm relative to the vessel, thereby to restore the separation to within the predetermined range.

The method may further comprise the step of monitoring whether mooring means on the arm is attached to the floating vessel and in the event of detachment, automatically disconnecting the loading device from the floating vessel.

In the event of automatic disconnection of the loading device from the floating vessel, the thrust means is preferably operated to move the arm in the first direction away from the floating vessel.

The invention will now be described in detail, by way of example of only, with reference to the accompanying drawings in which :

Figure 1 is a schematic diagram of an apparatus for transferring fluid between two floating vessels in accordance with one embodiment of the invention;

Figure 2 is a cross section of the rigid arm shown in Figure 1 along the line A-A;

Figure 3 shows the apparatus of Figure 1 from above (in solid lines) and when not in use (in dotted lines); and

Figure 4 is a schematic diagram of an apparatus for transferring fluid between a seabed pipeline and a vessel in accordance with a second embodiment of the invention.

Referring now to Figure 1, a first floating vessel 10 is shown, which may be a production or storage vessel moored to the seabed by any conventional and appropriate means. A second floating vessel 11, which may be a shuttle tanker for transporting fluid such as liquid natural gas away from the production/storage vessel 10, is located nearby. The transfer apparatus 12 is shown in use, connecting the two vessels 10, 11.

The transfer apparatus 12 consists of a rigid arm 13, typically of space frame type construction. As shown in Figure 2, the arm 13 may be formed of three longitudinal members 14 arranged in a triangular form and joined by a number of transverse bracing members 15.

Piping 16, for example rigid steel piping, is attached to the arm and carries the fluid being transferred. The piping 16 may be located inside one or more of the longitudinal members 14 and insulation (not shown) may also be provided. This construction protects the piping 16 but also allows the possibility of inspection of the piping 16.

At a first end of the arm 13, attachment means 17 is provided for attaching the arm 13 to the first vessel 10. The attachment means 17 may be constructed in any convenient form which includes articulations allowing the arm 13 to pivot about at least two axes relative to the vessel 10, preferably the vertical axis 18 and the horizontal axis extending into and out of the plane of the paper. The attachment means 17 is sized such that the arm 13 is located underwater at a depth greater than the maximum draught of both the first and second vessels 10, 11.

At the second end of the arm 13, float means 19 is provided which extends upwardly from the arm 13 and projects above the water surface.

A loading device 20, which is preferably a cryogenic loading device of known form, is located on the top of the float means 19. Articulations may be provided to allow the loading device 20 to pivot relative to the float means 19. The loading device 20 is connected to the piping 16 and is connectable to the second vessel 11 to allow transfer of fluid from the piping 16 to the vessel 11. Preferably the loading device 20 is configured to allow fluid pumped from the first vessel 10 to be readily returned to it, for example in the case of an emergency disconnect from the second vessel 11.

The piping 16 is preferably provided with flexible connections such as swivel joints or flexible hoses where necessary to allow it to bridge the various points of articulation in the apparatus 12.

The rigid arm 13 is preferably designed to be of a suitable length such that in use its second end will be adjacent a midship portion of the second vessel 11.

At the lower end of the float member 19, one or more thrusters 21 is located. The thruster 21 is powered and controlled from the first vessel 10, for the purpose described further below.

When transfer of fluid to a second vessel 11 is required, the thruster(s) 21 are used to rotate the arm 13 about the vertical axis 18, for example to rotate it anti-clockwise if viewed from above in Figure 1, so that it does not obstruct the area around the stern of the first vessel 10. The second vessel

11 can then be manoeuvred into position adjacent the first vessel 10 as shown in Figure 1.

Once the second vessel 11 is in position the thruster(s) 21 are operated again to rotate the arm 13 in the opposite direction to bring the float means 19 and loading device 20 adjacent preferably the midship portion of the second vessel 11. The rigid arm 13 is moored to the vessel 11 by any suitable mooring means (not shown). The loading device 20 is connected to the appropriate fluid receiving apparatus on board the vessel 11 so that fluid from the piping 16 can be transferred to the second vessel 11. When transfer is complete, the mooring means is disconnected from the vessel 11. The thruster(s) 21 are then operated to rotate the arm 13 away from the vessel 11,allowing it to leave the area unobstructed.

According to the present invention, when the loading device 20 is moored to the vessel 11, the thruster(s) 21 are also employed to maintain the rigid arm 13 in a substantially fixed position relative to the vessel 11, to ensure that no unacceptable loads are imposed on the loading device 20 and various interconnections between the piping 16 and the vessel 11.

A position monitoring device 22 is mounted on a point on the rigid arm 13 to monitor continuously the separation of the rigid arm 13 from the hull of the vessel 11. For example, the position monitoring device 22 may act by electronic or visual means. A control system (not shown) preferably mounted on the first vessel 10 receives information from the position monitoring device 22. If the rigid arm 13 and the vessel 11 move towards or away from one another so that their separation is no longer within an

acceptable range, the control system responds by operating the thruster(s) 21 to move the rigid arm 13 in an appropriate direction so as to restore the arm 13 and the vessel 11 to within an acceptable separation range. In this way, any relative movement due to the action of wind and waves can be accommodated to avoid the risk of damaging the transfer apparatus 12 and/or the vessel 11.

Preferably, the invention also comprises means to monitor whether the mooring means is actually attached to the vessel 11. If the mooring means becomes accidentally detached from the vessel 11, the control system operates to automatically disconnect the loading device 20 from the vessel 11, to avoid any damage to the loading device 20 which might occur if the separation of the vessel 11 and the rigid arm 13 changes significantly due to detachment of the mooring means.

Furthermore, if the control system operates in this way to disconnect the loading device 20 from the vessel 11, it also operates the thruster(s) 21 to move the rigid arm 13 well away from the vessel 11, to avoid the danger of collision.

In this way, the safety of the transfer operation is improved and the service life of the transfer apparatus increased.

When the transfer apparatus 12 is not being used, it may have its second end secured to the first vessel 10. For example, if the rigid arm is attached to the stern of the vessel 10, it can be pivoted back round so that its second end can be secured to the vessel 10 towards the bow region as shown in dotted lines in Figure 3. In this way the transfer apparatus 12 is

able to withstand extreme weather conditions which may exceed its design parameters. It also allows inspection, repair and maintenance to be carried out more easily.

Although the invention has been described with reference to transferring fluid between two floating vessels it will be appreciated that it is also applicable to transfer between a fixed structure and a vessel.

For example, as shown in Figure 4 the fixed structure 22 may comprise a base 23 mounted on the seabed from a column 24 rises to above the surface of the water. The base 23 may be a well-head, or connected by a seabed pipeline to a well-head or onshore plant.

It will be appreciated that the invention provides an improved fluid transfer system and that other modifications and variations to the specific embodiments described are also possible.

Claims

1. Apparatus for transferring fluid between a first structure and a floating vessel, comprising a rigid transfer arm defining a fluid conduit for receiving fluid from a first structure, means to attach a first end of the arm to the first structure so as to allow the arm to pivot about at least two axes, loading means located at the second end of the arm and attachable to a floating vessel for transferring fluid from the fluid conduit to the floating vessel, wherein the apparatus is provided with thrust means operable to rotate the rigid arm relative to the first structure about a substantially vertical axis in use, position monitoring means to monitor the separation of a point on the arm and the floating vessel and a control system operable to actuate the thrust means if the separation is outside a predetermined range, so as to move the arm relative to the floating vessel thereby to restore the separation to within the predetermined range.

2. Apparatus as claimed in claim 1, further comprising mooring means to moor the apparatus to the floating vessel, means to monitor whether the mooring means is attached to the floating vessel and means to automatically disconnect the loading device from the floating vessel if the mooring means becomes detached from the floating vessel.

3. Apparatus as claimed in claim 2, wherein if the loading device is automatically disconnected from the floating vessel, the control means is operable to actuate the thrust means to move the arm away from the floating vessel.

4. Apparatus as claimed in any preceding claim, wherein the first structure is a floating vessel.

5. Apparatus as claimed in any preceding claim, wherein the first structure is a seabed mounted structure.

6. Apparatus as claimed in any preceding claim, wherein the rigid arm is a space frame construction having a plurality of longitudinal members joined by a plurality of transverse bracing members.

7. Apparatus as claimed in claim 6, wherein the fluid conduit is located inside at least one of the longitudinal members.

8. Apparatus as claimed in claim 7, wherein insulation is provided around the fluid conduit.

9. Apparatus as claimed in any preceding claim, wherein the fluid conduit is provided with flexible connections allowing it to bridge the pivot points in the apparatus.

10. Apparatus as claimed in any preceding claim, wherein the loading means comprises a cryogenic loading device.

11. A method of transferring fluid from a first structure to a floating vessel using the apparatus as claimed in any preceding claim, comprising the steps of: actuating the thrust means to pivot the arm in a first direction about an axis defined by the attachment means relative to the first structure, moving the floating vessel into a position in the

vicinity of the first structure, actuating the thrust means to pivot the arm in a second direction opposite to the first direction so as to bring the loading means adjacent the floating vessel, connecting the loading means to the vessel and transferring fluid from the fluid conduit to the floating vessel, disconnecting the loading means from the floating vessel, and actuating the thrust means to pivot the arm in the first direction away from the floating vessel; wherein, while the loading device is connected to the floating vessel, monitoring the separation between a point on the arm and the vessel, and operating the thrust means if the separation is outside a predetermined range so as to move the arm relative to the vessel, thereby to restore the separation to within the predetermined range.

12. A method as claimed in claim 11, further comprising the step of monitoring whether mooring means on the arm is attached to the floating vessel and in the event of detachment, automatically disconnecting the loading device from the floating vessel.

13. A method as claimed in claim 12, wherein in the event of automatic disconnection of the loading device from the floating vessel, the thrust means is operated to move the arm in the first direction away from the floating vessel.

14. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

15. A method as substantially hereinbefore described with reference to the accompanying drawings.

INVESTOR IN PEOPLE

Application No:	GB 0124570.3	13	**Examiner:**	Dave McMunn
Claims searched:	1-15		**Date of search:**	3 April 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
Y	1, 11	GB 2,328,197 A	(BLUEWATER). See Fig 3 & thruster 21
Y	1,11	GB 2,328,196 A	(BLUEWATER). See Fig 1 & thruster 21
Y	1,11	GB 2,065,307 A	(FMC). Note position warning system allowing manual adjustment
Y	1,11	GB 2,041,578 A	(N S C). Note arm position monitor and control system
Y	1,11	EP 0,171,136 A1	(EMCO WHEATON). Note position warning system allowing manual adjustment

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

B8E.

Worldwide search of patent documents classified in the following areas of the IPC[7]:

B63B.

The following online and other databases have been used in the preparation of this search report:

WPI ,EPODOC, JAPIO.